RESUMED **[10.29 am]**

COMMISSIONER: We reconvene at 10.30 and I welcome Dr Tim Johnson from Jacobs. Mr Jacobi.

MR JACOBI: Quantitative analyses and business case for radioactive waste storage and disposal facilities in South Australia. Quantitative analyses will be undertaken to determine engineering procurement, construction and life cycle, operating and maintenance costs associated with the possible development for hypothetical types of radioactive waste management facilities in South Australia. The scenarios to be considered are surface, near surface low-level waste management facility, a tunnel blow and intermediate level waste management facility, a centralised dry cask spent fuel storage facility and a deep geological disposal facility. To provide a presentation in relation to that matter is Mr Tim Johnson of the Jacobs Engineering Group.

COMMISSIONER: Dr Johnson please proceed.

MR JOHNSON: Okay. Thank you very much. Well, I am presenting on behalf of Jacobs and the actual presentation was put together with my colleague (indistinct) Cook and our subject matter experts, NCN and Geneva. The approach that we are taking in this analysis aligns with the request for proposal which we initially responded to and we are looking at four generalised types of waste storage and disposal facilities. As identified a moment ago, these are – this is terminology we have chosen in agreement with you because internationally there's quite a lot of disagreement about the terminology in this area. Interim storage facility for high and intermediate level wastes. This will be a surface facility. A geological disposal facility (GDF) for high-level waste and this will be a deep underground facility. An intermediate depth underground repository which will probably be co-located with the GDF and I will come on to that a bit later. For intermediate level wastes and finally a low-level waste repository (LLWR) which is a near surface facility.

Our investigation will look at the business case to manage international waste which does not have a local solution, as well as potential Australian waste from a nuclear power programme. So what types of waste are we actually considering in this study? Well, we are going to be looking at the following, and again, it's to simplify the following of three waste streams. The first waste stream we are calling high-level waste and mostly the high-level waste is spent nuclear fuel. Potentially with some stabilised waste in the reprocessing of spent fuel. This waste we assume will be delivered in casks for eventual disposal in a deep geological disposal facility, the GDF. The second sort of waste we are looking at is the intermediate level waste, mainly from nuclear power plants, will be delivered in robust containers, again for eventual disposal in an intermediate depth repository. Finally we have low-level waste arising from Australian nuclear related activities, e.g. medical waste, packaging, clothing for disposal in a low-level waste repository. This low-level waste repository will also probably be picking up certain amounts of waste which are generated during the treatment of the high level and intermediate level waste.

So if we look at how much waste we are actually going to be managing or considering, let's look at some key assumptions. There is an existing and well-documented stockpile of high-level waste, largely it's spent fuel and it is held internationally. This is documented and this is waste which is actually in need of a permanent solution. Similarly, there is a lot of data available on the willingness to pay of customers for the management of their high and intermediate level wastes. So we look at published holding costs. We have identified some potential customer countries and the ones we have identified do not reprocess their spent fuel at the moment; that is partly because of the exclusions we are putting on to this study. We are making the – excluding waste accruing from countries which already have advanced waste management programmes, e.g. USA, some European Union countries, Russia and China. We have made the assumption that these countries will continue to store and dispose of their own wastes. Similarly, international low-level waste is excluded. It is assumed that local and national solutions predominate for the low-level waste.

How are we going to approach this? We are going to model the total amount of radioactive waste requiring management over time and this will be based on the size of current and future stockpiles for both existing nuclear power programmes and those programmes which are in the advanced stages of planning. We are going to use typical rates of high level and intermediate level waste creation for light water reactors because these are the bigger part of the market. Then we are going to estimate the percentage or the fraction of the total market which we believe South Australia will be able to capture and an upper and lower bound on this depending on market and other factors. So this should give us the quantity over time of waste which will be coming in to the country.

Let us look at the general assumptions regarding the waste storage and disposal industry. The first thing to comment on is that it is a very long timescale activity. The timeline just for licensing, developing and commissioning the facilities are long and the facilities themselves are assumed to operate for many decades. We are saying, as a working assumption, 25 plus years for development, 60 to 100 plus years for operation. Within that, we will be looking at different scenarios to establish the range of likely timescales to bring these facilities in to operation and we note, in that context, that surface storage is expected to be developed more quickly than underground disposal and as typically the value of waste or the cost of waste is transferred at the time of the responsibility transfer, the revenues will proceed the cost of the underground disposal. The other general assumption we note is that both capital and through life operational costs are significant; it is not just an upfront expenditure.

What I will do now is talk briefly on the key assumptions for each of the individual facilities under consideration. I have chosen to order these in the way that the waste tends to flow, so the first one we're talking about is the interim storage facility and this is also known internationally as the interim spent fuel storage but in this case it will cover more than just spent fuel. We are assuming a five to 10 year lead-time to operations after the siting and approvals were in place. We are saying that siting and approvals timescale is a bit uncertain but once you have got that we can start actually construction and the design and the building then we have five to 10 years. We are assuming it will be located near to a new dedicated port in South Australia. Experience elsewhere has shown that new ports are more suited to this sort of operation than trying to adapt existing ports. The facility will be close to the port and we are assuming it will be connected by a short haul road. The IFS, or see both high-level waste and intermediate level waste in specialist casks and containers for surface storage. We will size it to meet the model demands we talked about previously and we will make the assumption that construction will be modular, that we won't build the full-scale facility on day one; we will build enough for a few years and then keep ahead of ourselves by building future additions to it as time goes by. We are also making the assumption that it is in a position where it can be connected to power, water and other networks and it will have a local workforce.

We move on to the geological disposal facility. This has got the most onerous siting constraints and we expect it to be located in a region with suitable geology, hydrogeology and geochemistry to a depth of at least 500 metres for deep underground disposal. Given these constraints, it is reasonable to assume it will be located several hundred kilometres from the interim fuel storage facility. Because it requires an enormous amount, or a large amount of underground work and so on, we are estimating it will take at least 15 years time to operations after the siting and approvals were in place. We also assume that it will be connected to the interim fuel storage by a heavy railway and there are heavy railways around in the world which have a suitable (indistinct) for this. At the geological disposal facility both high-level waste and intermediate level waste will be encapsulated for permanent disposal. We are assuming here that the actual capsules which will be involved will be fabricated elsewhere and would be brought to the GDF where the encapsulation plant will be located.

Again, the facility will be sized to meet model demands. As it is several hundred kilometres from the IFS, we are making the assumption that there won't be any power and water networks there and so it will have standalone power and water supplies. This is very common of course in South Australia where you have (indistinct) mines and so on. Similarly, we have assumed that it will not have a local workforce. If we move on to the third repository which we are calling the intermediate depth repository we are making the assumption that it is co-located with the GDF. This isn't essential but there are significant operational and capital benefits in having it co-located. It will share common infrastructure and workforce with the GDF. It will take quite a long time to construct; we are estimating 10 to 15 years time to operations after siting and approvals. In the same way that high-level waste will be encapsulated, the intermediate level waste will be encapsulated for permanent disposal. And it will be sized to meet model demands.

COMMISSIONER: Tim, could I just stop you there and go back to the previous one. When you say you don't assume a local workforce - - -

MR JOHNSON: Mm'hm.

COMMISSIONER: - - - what precisely do you mean by that?

MR JOHNSON: What we assume by that is that the facility will be in a rural or remote area and it will be a long way from anywhere and the workforce will come in either by rail or by plane or by car and will stay for a certain period of time, often called FIFO.

COMMISSIONER: Yes. Well, that – I don't know that that is necessarily an assumption for us but now I understand what you mean.

MR JOHNSON: It was just due to the location of - - -

COMMISSIONER: Yes.

MR JOHNSON: - - - the GDF.

COMMISSIONER: Yes.

MR JOHNSON: So if we move on to the low-level waste repository, this is a surface facility. It's got fewer physical constraints on siting, ie issues of climatology, geological stability than the ILR and GDF, and indeed there are low level waste repositories operating internationally for some decades. Other countries have found how this can be done. It could be co-located with other facilities. It is not necessary but it may well be cost beneficial. For the purposes of this study, we're assuming it will be near to but not necessarily co-located with the IFS. We're assuming - and that assumption leads onto a local workforce and connections to power and water networks.

We're also assuming that it will receive compacted, sealed, low-level waste, predominantly by road - waste which will be coming from the GDF and intermediate (indistinct) facility obviously will come in by (indistinct) again sized to meet model demands. I mean, note in that context the volumes of low level waste are significantly greater than intermediate high level zones. So those assumptions were really specific assumption to the individual facilities. There are some more general assumptions which I outlined on this slide.

Initially, South Australia has large areas with suitable geology for a GDF and IDR facility, we understand without having done any detailed investigation. So we're making that assumption and we've also made the assumptions that there were a number of coastal locations which are suitable for the interim storage facility. We note and assume that all four types of facility form links in the service chain for the management of waste. It will be not very efficient, in our view, and we've assumed that all four will be done at the same time or in a coordinated program.

We are going to undertake business case modelling to incorporate (indistinct) times to establish and a legislative, regulatory siting design in other processes prior to construction and operation, and we've also noted some other specific assumptions related in particular to the (indistinct) part of the waste. The (indistinct) part of the high level waste is likely to have spent 10 years in wet storage at the source location. We're going to assume 10 years - that is a typical international number. Some waste may be released earlier than that, some rather longer. But 10 years is a good working number and that will be the time the wet storage - prior to delivery to the ISF by ship and then the last bit by truck.

This waste will still be producing quite a lot of heat and it will - we are making the assumption it will have to have 30 years storage at the ISF before it's relocated to the GDF and clearly that gives a certain amount of time to build the GDF in a phase program. The casts - the spent fuel and high level waste come in are very specialist. We are making the assumption that these will be supplied by customers. When the waste is taken up to the GDF and the intermediate depth repository, it will be taken out of those containers and they could be returned and re-used, and we've made the other assumption that the shipping cost will be met by the customers. We'll start costing from the point the waste arrives actually at the port facility and the main assumption that we made is the potential benefits and possible costs manufacturer undertaking the shipping and other support services are excluded from this analysis. We're trying to keep it a fairly clean within Australia analysis.

So those are the main assumptions we made about the various facilities and the amount of waste. Let's move on a little bit and talk about the cost estimation processes that we're undertaking. We're going to be doing our cost inputs at the Australian Association of Cost Engineers class 5, or concept level and this give an anticipated uncertainty of minus 50% to plus 100%, and this concept level is appropriate given the uncertainties regarding the design location technologies and so on. We're going to approach the assumptions for capital and operating costs in the following way: We'll consider the overseas experiences and here we'll both be looking at designs and costs of overseas projects and plan projects. From that, we'll develop South Australian equivalent costs.

We'll develop both so-called top down and bottom up costs, as a cross check. What we mean by this is a top-down cost will take an overseas facility, convert the price of that facility to South Australian equivalent costs primarily by saying how does it size compare? Does it do the same number of things? We'll take the variable cost and we'll factor it, just to make it look like the size and type of facility in South Australia. The other approach we'll do is the bottom up approach and here we'll take the design of a facility rather than its cost. We'll look at the elements of the design, the various bits of equipment, the number of kilometres of tunnel and so on, and so forth, and estimate the cost of those individual items and components, and add those up to (indistinct) process.

Our hope and expectation is that we'll get a reasonable cross check, but we're yet to find out and the other thing we'll do in the cost estimation is we'll consider exactly when those costs will be incurred and work out the phasing of the costs over time. What I can show now in the next couple of slides are some of the reference projects that we've identified and our colleagues in Geneva in particular have identified for us, for the various facilities. The GDF and intermediate depth repositories share some common features and so we've looked at international concepts that is at a high level and from these we've identified that the most appropriate concept for South Australia - and this is the one we've assumed - is a basement block concept and there are several, but we have chosen this specific following based on what concept designs for further valuation.

For geological disposal facilities we've got the Swedish Finnish KBS3H in tunnel disposal concept which has an engineered barrier adapted to the arid environment which is appropriate for (indistinct) concept and for the intermediate depth repository we've used the UK reference for disposal concept, again for (indistinct) and this disposal concept has been designed to accommodate a wide range of low to intermediate level wastes. If we look at the next slide the specific data sources, if anybody's interested, are available and these you'll notice are at different periods. They range from 2005 for the finished cost estimate and the most recent Swedish one is 2013, so it is very near to current.

We would also note that we are taking advantage of a slight further studies here, but as well as the basement rock concept we will look at some of the surface infrastructure costings coming out of a high isolation concept study in Switzerland, but that's only for the above surface or surface infrastructure. When it comes onto reference projects for the (indistinct) storage facility, again there are quite a few of these facilities worldwide and there are quite a few different (indistinct) types of cast and so on. We've reviewed the variants and we've identified a working assumption, but we'll assume the Holtech system - so that's the casts, the lifting equipment and so on will be brought in as that system.

From a design perspective, we've looked at a private fuel storage project in the USA. We've looked at a more comprehensive Electric Power Source Institute of USA study in 2009 and the United States Department of Energy study in 2013. So we have a reasonable amount of data there and the costs will come from those studies, and also from International Atomic Energy Association costing of spent nuclear fuel storage report, again from 2009. So what sort of cost factors do we bring in to the analysis? The first major cost factor is location-related costs. We recognise that the interim storage facility and the low-level waste facility will be moderately closer to existing infrastructure whilst there will be very little or no infrastructure at the location of the GDF and interim depth facility. So we're looking at location-related costs.

We're looking at costs of escalation. We've noted that the previous studies are a number of years old and we all use building price index increases and so on to factor those.

We'll look at the scale factors compared with the overseas facilities in both the top down and the bottom up cases, and we'll look at the other costs, particularly upfront costs and ongoing phase expansion costs, and we'll look at the sequences of facility planning construction operations, mid-life renewal and eventual decommission.

In addition to these facilities where you can almost envisage them as having a fence around them, you have a lot of enabling infrastructure and we've identified the enabling infrastructure in two different categories; hard infrastructure. This is airport facilities and we've identified that there'll most certainly be a need for an airport immediately at the GDF and we've identified the need for a new port adjacent to the interim storage facility. There'll be (indistinct) road connections between these facilities and there'll be water and (indistinct) connections, and or stand-alone systems for the various utilities - and I just mentioned the two most important ones there. As the GVS site is some way away from existing infrastructure we'll need to consider accommodation at that site. In addition we see there's a fair bit of agency or human infrastructure. We need to develop the legislative basis for the industry and we need the expansion of regulatory bodies and there will be a lot of corporate interdepartmental works. We are going to put cost estimates against both (indistinct) and agency of human infrastructure costs.

Other foreseeable costs – and this is a shopping list that isn't complete but it takes you down further into the depth of the costing. There will be costing associated with site selection and agreement and we've identified from international experience that that could be quite a large number. Then there's the evaluation and environmental impact analysis. This selection and agreement not only includes the site, it includes the transport corridors. Once the site has been identified and costs have been put against identifying the sites, there will be both concept and detailed design, land acquisition and use costs, again both for sites and transport corridors.

We will put assumptions in for costs of (indistinct) logistics because although we have assumed that the customers will pay for the shipping, we've assumed that any logistic movement of the waste once it arrives in Australia will be part of the costing. There's costs for facilities maintenance. We identify significant costing which will assume the regulatory licensing and inspection costs. Then there are post-closure activities. The post-closure activities obviously will be site specific. In addition to that we have the direct workforce costs, site admin operations, quality assurance, security, et cetera.

At this stage if we follow those two specific work streams, one looking at the demand and another one looking at the cost estimates, then we have got two sets of data which we'll use to form the bases of the commercial modelling. We will identify initially the revenue requirements to meet various rates of return, calculated at a range of discount rates. Once we identify those revenue requirements we can compare those requirements with the published knowledge of customer range of willingness to pay values. So we can check how the two compare.

We'll consider generic scenario analyses. Some of these are mentioned in the slide, including time to gain licences, the size of the facility, the speed of implementation, the distance away from the interim disposal facility, where the GDF is located, hence the length of railway, the phasing of construction, the size of demand and the phasing of demand, et cetera. So the model will be set up so we can do a large number of scenarios in a fairly efficient manner.

We note also that there are linkages with other work streams that have been commissioned by this Commission and we note that a South Australian waste management capability would address the waste requirements from a nuclear power plant which will need some access to GDF and obviously a linkage with the fuel manufacture and enrichment stream. Through our work and ongoing work we'll liaise with the other consultants through the Commission to make sure we take note of these linkages.

So from this work what are the outputs that we envisage? We envisage cost ranges with assumptions and evidence for the four types of facility and its supporting infrastructure. We'll look at scenarios for individual or joint operation. We mentioned earlier joint operation effectively of the geological disposal facility and the interim depth repository. We'll look at opportunities for phase development. We will identify revenue estimates with assumptions and evidence and we'll derive commercial outcome measures, including internal rates of return, net present value and so on at various discount rates. Most importantly, we'll undertake a sensitivity analysis to address key areas of uncertainty and demonstrate overall confidence in the findings. That is it, thank you.

COMMISSIONER: Thanks, Dr Johnson. I don't think we've got any questions. We'll adjourn till 11.15 when we'll look at analysis of electricity generation from nuclear fuels.

ADJOURNED **[10.54 am]**